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## ABALONE OR HALIOTIS SHELLS OF THE CALIFORNIAN COAST.

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Although the coast of California produces, as a rule, dull or sombre tinted shells, yet in one family of molluscs the Californian province stands preëminent. This family is composed of shells familiarly known on the West Coast as Abalone or pearly-ear shells. Among scientists the shells are called *Haliotis* and the family Haliotidæ. In the size of all its species of Haliotidæ California rivals the world. Japan has one fine species *Haliotis gigantea* Chemnitz, that compares very favorably with the large shells of California, and this species is also represented on the West Coast of the U. S. by a variety. Another fine shell that compares favorably with the Californian shells is *Haliotis mida*, the first shell of this family named by the great Linneus or Linnè, who described it in 1758. Australia also produces a large species, but for the most part shells collected on other coasts are small, ranging from four to one inch in length.

In the geographical distribution of this family, the "center of distribution is in the Australian and adjacent seas."<sup>1</sup> Besides those collected on the coast of California and Lower California, these shells are found as far north as Alaska, also on the coasts of Kamtchatka, Japan, China, Philippine Islands, New Hebrides, New Caledonia, New Zealand, Auckland, Id., Australia, Malay Archipelago, Ceylon, Red Sea, West Coast of Africa and at the Cape of Good Hope, Canary Islands, Mediterranean and Adriatic Seas, French and English Coasts of the Atlantic, and also at the Cape region of South America. It has often been remarked that "not a single species" has been "found upon either coast of South America, or upon the East Coast of North America," but, in 1869, Pourtales dredged a small *Haliotis* in 200 fathoms near the Florida reefs. The

<sup>1</sup>Pilsbry.

shell was named by Dr. Wm. H. Dall *Haliotis pourtalesii*, but in the great fire of 1871 in Chicago, this little specimen together with the "entire collection of Pourtales and Stimpson," was burned. In 1887-88 the U. S. Fish Commission Steamer Albatross dredged a number of shells on the West Coast, and, at the Galapagos Islands, in the Pacific, on the West Coast of South America, two specimens of *Haliotes* were dredged. And, what is remarkable, the shell found in Florida from the bed of the Gulf Stream and the one from the Galapagos group were pronounced by Dr. Dall the same species with scarcely a doubt. The latter did not contain the animal and was not quite one inch in length.<sup>2</sup>

In the Manual of Conchology, Mr. H. A. Pilsbry says of the family Haliotidæ in geologic ages: "Of the genealogy of the family little is known. A few fossil forms not differing materially from the recent ones, have been discovered in the Pliocene and Miocene and one in the upper Cretaceous of Germany. Others will probably be found when the Australian Tertiary and secondary strata are more fully explored." Two species of Abalones are found in the Quarternary or Plistocene formation in Southern California.

There are about 85 species and well defined varieties of shells in this family. On the Californian coast six distinct species are collected and also two or three varieties. Some of these species are found as far south as Cape St. Lucas, Lower California, and one species extends to Alaska; this is supposed to be a variety of the Japanese species, reaching the Californian coast by way of Alaska. The species is *Haliotis gigantea* Chemnitz var. *H. kamtschatkana* Jonas. Besides this northern species, *H. rufescens* Swainson, *H. fulgens* Philippi; *H. corrugata* Gray, *H. cracherodii* Leech and *H. assimilis* Dall are collected. The last named is a deep water species.

The generic name *Haliotis* was also given by Linné in 1758. It is from the Greek *hals*, sea and *ous* ear, but wherever these shells are found they have local names. In California they are popularly known as "Abalone," of "uncertain ety-

<sup>2</sup>See Preliminary Report on Albatross Mollusca by William Healey Dall, Curator Dept. Molluscs. (Proc. Nat. Mus., Vol. XII, 1889).

mology." Some writers think the name is of Spanish origin<sup>3</sup> but a well known Spanish scholar, one of the Jesuit Fathers, told me he thought the name was a "provincialism." It is said these shells are called "Awabi" in Japan. The local names given to the shell in different countries refer usually to the shape of the shell, and, being translated, mean ear-shell, ear-of-the-sea, Venus' ear, etc.; also on account of its nacreous lining, Mother-of-pearl-shell, and because of the holes in the shell, "six eyes." The beautiful nacre or mother-of-pearl in the interior of these shells, and the rich colors visible when the epidermis or outside layer has been removed, has given rise to color names. The most beautiful shell, in the interior, is the green abalone (*Haliotis fulgens*). The green and blue nacre is as effectively blended as the colors in a peacock, and is indiscribably rich in tone. The centre is especially rich in iridescent effect. This center is scientifically known as the "muscular impression" for it is at this place that the animal is firmly adherent to its shell, though young shells are not marked by this "area of the muscular impression." In some specimens it is horse-shoe-shaped. In an article on the Abalone Fishery in "The Fisheries and Fishing Industries of the U. S." (U. S. Commission of Fish and Fisheries 1887), Earnest Ingersoll says in referring to this muscle scar: "In aged specimens the part to which the muscle is attached is raised above the level of the rest of the interior and presents a roughened or carved surface of irregular shape, often fancifully imitative of some other object. The writer has seen one which thus contained a singularly correct profile of Napoleon I." Instead of the muscular impression being "raised above the level," my observation has led me to conclude that with age the muscle scar is, as a whole, depressed.

The red abalone (*H. rufescens*) does not receive its name from the color of its mother-of-pearl, as does the green shell, but from the red margin that outlines the aperture and the beautiful red displayed on the outside when the shell is decorticated by the use of acids or the grindstone. Another species (*H. cracherodii*, named for a Mr. Cracherod) when submitted

<sup>3</sup>From *aulon* or *aulone*.

to the same treatment shows a black exterior and this is the "black abalone." It is also called the "white abalone" in reference to its pearly interior and exterior, if the calcareous layers have been ground off leaving only the mother-of-pearl on the outside, as is often the case. A species with corrugations (*H. corrugata*) presents a reddish-purple color when ground off by a skillful workman. All these shells take a beautiful polish; but, while the shells are made more attractive to the popular taste, scientifically their value is depreciated after they fall "victims," as Carpenter expresses it, "to the grindstone and acids." Physicists tell us that the play of tints visible in the nacre or mother-of-pearl is caused by the action upon light of the tiny layers composing the nacre. "These layers are microscopically corrugated and their edges meet the rays of light and partly decompose them as do the rain drops in a rainbow producing a play of colors." (I once dissolved the inner layers of an abalone shell in muriatic acid, the dish was placed aside for several hours and on seeing it again I was surprised to find a beautiful sediment of iridescent mother-of-pearl; pressure was applied, and the play of colors was gone. The result was new to me at that time and was a pleasant surprise).

Typical shells of the Gastropoda (so named because the "under side of the body forms a muscular foot for gliding along"), the class to which abalones belong, are spiral in their form. Although these shells appear flat, a close inspection shows a well developed spire, but in most species, the spire is small and the basal or body-whorl is unusually developed and depressed, and this gives the shell an appearance as though it were only one valve of a bivalve, for which it has often been mistaken when seen by persons unacquainted with these forms. The shells have a row of open holes usually from five to nine, on one side, but these vary in number as the animal grows older; the holes close, until old shells have been seen with only one or two holes left open.<sup>4</sup> These holes are on the left side of the shell and through them the tentacles of the animal are often protruded. When the animal is resting upon

<sup>4</sup>A California Conchologist has a shell with *all* the holes closed.

a rock, a slight blow upon the shell often causes the shell-fish to adhere more firmly to the rock and at the same time discharge jets of water out of every hole. When entirely at rest the abalone adheres to the rock and is as completely covered by his shell as a watch would be under an inverted saucer, excepting that the five or more holes in the shell admit the entrance and exit of water. The large muscular foot with its epipodial ridge bordered with cirri extends outside of the shell when the animal is gliding along. This foot is to all appearances only a muscular expansion of the body. The animal has no operculum or trap-door, as in most families of this class, as it is like the limpet in having no use for an operculum. Abalones have a short head and eye peduncles. The gills or branchia, intestines, etc., are all on the same side of the shell as the holes, and the "columellar margin is produced into a flattened spiral plate," that forms a ridge sufficiently broad to protect all the digestive organs. The heart has two lateral auricles. The mantle is cleft at the row of holes extending thus "as far back as the last open hole." The odontophore<sup>5</sup> or radula is large, and the variety and size of the teeth on this lingual ribbon can be seen without the aid of a microscope. A section of the odontophore makes one of the most attractive mounts furnished by the radula of molluscs.

Reference was made to the fact that sometimes old shells had only one or two holes open when the animal was very old; when such is the case the shell is usually covered with a growth of vegetation, worms, or other molluscs. Whole colonies of *Serpulorbis* attach themselves to one shell making a very heavy load for a shell-fish to carry, even one so muscular as the abalone. Although they do travel somewhat, it is not improbable that with age the animal becomes more and more sedentary until almost incapable of locomotion. An abalone brought from the Pacific, about 24 miles away, after it had shown very little appearance of life, crawled from a pail of sea water, eighteen inches in one night, where it was found dead in the morning. The abalone marks his passage by a

<sup>5</sup>The odontophore, sometimes called the "tongue" or "lingual ribbon" is set with rows of sharp siliceous teeth. In a large abalone it is about 3 inches in length.

trail of mucus in the same way that a land snail (*Helix*) leaves a trace of secretion in his wake. Besides the extraneous growth on these shells, they are the home of numerous pholads which burrow into the shell the same as into soft rock. The little domiciliary squatters often cause protuberances in the interior of the shell where the borer has drilled through the epidermis and calcareous portions into the nacre, which is always supplied sufficiently to resent the encroachments of domiciliaries. Dr. Robert E. C. Stearns of the National Museum has written an interesting paper on animals that encroach on the domain of others,<sup>6</sup> and it is illustrated with a plate showing these protuberances in an abalone shell. A red abalone that showed, on the inside, the raised nodule or protuberance indicative of the presence of a small rock-borer, on the outside of the abalone showed no perforation as usual, but, instead, there was a round depression of nacre, the pholad (*? Penitella parva* Tryon) had been completely covered with nacre, but a hammer and a chisel discovered the little bivalve that had been sealed up in his own domicile. As I broke the little pholad in getting it out of the abalone shell it could not be identified otherwise than doubtfully.

As pearls consist of coatings of nacreous secretion they are sometimes found in abalone shells. These will not compare with pearls found in the pearl oyster, as the latter are unrivalled. Pearls in abalones are often pear-shaped and green in color, in fact some of these so-called "pearls" are peculiar rather than beautiful. One fine pearl *baroque* (irregular) was taken from under the columella margin of a green abalone. It is the property of Mrs. Prof. Lowe of Pasadena, S. California, and is about  $2\frac{3}{4}$  inches long; it is three-cornered in shape, and at the widest and thickest part it is  $2\frac{1}{4}$  inches around.

As is well known the habitat of abalone is among rocks, where, at *very low* tide, they may be found huddled together in a corner of a rock in a rock pool, or hedged in between fissures of immense rocks, always as though hiding from the

<sup>6</sup>On certain Parasites, Commensals and Domiciliaries in the Pearl Oyster, etc. (Smithsonian Report, 1886, pages 339-344, with three plates).

light. Their dingy exterior almost of the same color as the rocks on which they rest, make them scarcely noticeable save for the protuberances that are visible on the rocks from which they are very difficult to remove, a trowel or wedge, etc., being necessary to dislodge them. Fishermen and Chinamen are the principle collectors of abalones. To illustrate the strength of muscle developed in this shell an anecdote is sometimes told of a man who was collecting some shells, when one of the shell-fish drew his shell so closely to the rock the man's hand was securely pinned to the rock and he was drowned. At one time the man is a Mexican, at another a Chinamen; the occurrence at one period is at Santa Barbara, at another San Pedro, but, the story always begins with "I have heard, etc." Any one who has collected these muscular fellows would be wary about allowing even a finger to be in close proximity to the shell, nor is it necessary to do so, the trowel or tool used to dislodge the shell is all that is needed. That men have lost their lives while collecting these shells there is no doubt at all, as the tide sometimes comes with fearful force on the slippery rocks. Three or four years ago the local papers reported the drowning of a young fisherman while getting abalones at San Pedro. Last spring a San Francisco paper told how a coyote was entrapped in a *Haliotis* which the coyote found partly raised from a rock, and, on inserting his muzzle underneath to secure a breakfast, the abalone had "closed down on him and kept him a prisoner."

As an article of food it is the general impression that the Chinese are the only consumers, but this is a mistake, although as an article of commerce only the Chinese seem to value it highly. At a lonely "point" in one of the Palos Verdes Hills we once found a large number of abalone shells around a deserted camp-fire, the fish had evidently been cooked on the fire, then eaten from the shell by the fishermen. A slice of abalone, before it is cooked, laid upon a platter might easily be mistaken for a slice of fish. They are pounded before cooking. As a soup this shell-fish is said to be very palatable and it has frequently been mistaken, by the uninitiated, for clam soup. As an export the fish is dried after being removed



from the shell. I have seen three and four dozen abalones dried and strung on a cord, in Mexican grocery stores, hung beside dozens of strings of red peppers or chilles so gratifying to the Mexican palate. Abalones, when dried, have the appearance of leather, excepting that they are oily in their appearance. In shape they are nearly oblong and two or three inches thick. The great muscular foot slopes backward over an inch before it is enlarged by the epopodial ridge with its numerous cirri, and this contraction is noticeable in the dried fish.

As an article of commerce the shells are of considerable importance, or rather have been, as it is said, the immense traffic has almost "stripped the coast as far south as Cerros Island," Lower California. Three hundred tons are said to have been shipped from the coast in one year. Fifty tons being handled by one man in a month's time. "The greater portion of these are (in 1889) collected on the coast of Lower California. The Chinese are the principal gatherers, notwithstanding they are prohibited by the Mexican laws. The shells are sold at \$20 to \$35 per ton, according to the quality."<sup>7</sup> When shells are sold by the bulk there is always a large percentage of dead and imperfect specimens, as the best shells are picked out and sold to retail dealers on the coast. A shell that is perforated by worms or molluscs is of no value as a polished shell. When the animal has been removed from the shell and the latter has laid on the beach subjected to the sun and the weather, the mother-of-pearl becomes dull and unattractive, and such shells are known as dead shells.

In California dead shells collected on the beach are often used, instead of stones, for rockeries, and also as borders for flower beds. It would be impossible to enumerate the ornamental uses to which abalones are applied. "In China they are broken up and used for inlaying in connection with lacquer work for which the Chinese are famous. The Mosaics of Europe are often adorned in the same way." Although the pearl oyster (*Maleagrina margaritifera*) is used where a pearly-white tint, such as seen in the pearl handles of silver table

<sup>7</sup>The West Amer. Scientist, April, 1889, p. 12.

knives, etc. is desired, yet in mosaics and work enriched by a display of iridescent tints the nacre of abalone shells stands preëminent. Inlaid work is so universally used that an enumeration of articles ornamented in this way is unnecessary, but mention may be made of one use of these shells in lacquer that to an American or European may seem unique; its use in a "pillow end." When we think of a pillow we imagine a billowy roll all done up in white, but, a Japanese or Korean has a very different idea. In the Korean collection in the U. S. National Museum are some small pillows and the following description is given of the ends of two of them:<sup>8</sup> "Pillow end (Be-ga-mo). Circular piece of wood, lacquered, incrustated with *Haliotis* shell. Figures represent a tiger under a pine tree; along the border is a band of arabesque." "Pillow end (Ja-ga-be-ga-mo). Disk of wood fastened in the end of a cylindrical pillow case, in black lacquer with *Haliotis* shell. Subject, the great dragon rising from the sea into the sky in the spring season." In describing these pillow ends Mr. Walter Hough says: "The Korean pillow is a cylindrical case stuffed with hair or rice straw. It has ornamented ends. The first one mentioned is  $8\frac{1}{4}$  inches in diameter, but is 'not part of a regular pillow,' being used as a 'arm-rest.' The second one is 8 inches in diameter."

As a medium for trade among the Aborigines of North America, abalones have been highly esteemed both for their beauty and importance when used as shell money. The shells in the latter case being cut "into oblong strips from one to two inches in length, according to the curvature of the shell, and about as third as broad as long." These were strung on a string and were used both as money and ornaments. Dr. Robert E. C. Stearns, Adjunct Curator of Molluscs in the National Museum, has written a comprehensive monograph upon the use of shells by the Indians, entitled "Ethno-Conchology, a study of Primitive Money," and in it is figured money made from abalones, which the Indians termed "Uhl-lo." In the recent excavations at the old historic town of

<sup>8</sup>Report of the U. S. National Museum, 1891, page 465.

Pachacamac, near Lima, Peru,<sup>9</sup> squares of mother-of-pearl were found in the graves of the Incas. These squares are only half the length of those figured in Dr. Stearns' paper. The pieces look like the nacre of abalones and each square has two holes drilled in it. As the graves, or burial place of Pachacamac is supposed to be over four hundred years old, these shell pieces are very interesting, revealing also the fact that the Incas considered shell ornaments valuable enough to be buried with their bodies. As these strips of solid silver, done up in a loosely woven cloth, were found in a mummy's hand, the pieces of shell were evidently not used as money, the silver having been cut for that purpose.

Dr. Stearns instances the purchasing power of an abalone from the fact that in New Mexico a horse had been traded for a shell. I was relating this incident to a friend who had spent some years with the Pueblos in New Mexico, and my friend said that that was not surprising, as, when she first went to New Mexico, some years ago, her brother bought her a good Mexican horse for \$6.00, and the Indians were always as glad to receive attractive shells as money. This would not be a very extravagant price for an Indian to pay for a fine *Haliotis*, as a shell dealer once listed to me *H. fulgens* as high as \$10.00. Whether any conchologist paid such price is unknown to me, but, a red abalone, when decorticated, has sold in Los Angeles for \$5.00, but it was a large specimen and beautifully polished.<sup>10</sup> Like other commodities abalone shells are variable in price according to the demand, as well as quality.

<sup>9</sup>In the private collection of C. F. Lummus, Los Angeles, Cal.

<sup>10</sup>It is related that as high a price as \$25.00 has been asked for an abalone having a peculiar muscular impression outlined in the interior of the shell.